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ABSTRACT

This study examined the influence of age, vocabulary knowledge, gender, ethnicity, and socioeconomic status (SES) on the geometric analogy performance of 4- to 6-year-olds. Subjects were 108 children between the ages of 48 and 83 months. Information on the age, ethnicity, and socioeconomic status of each subject was obtained prior to data collection. For the determination of vocabulary knowledge, Forms L and M of the Peabody Picture Vocabulary Test were administered. The Test of Analogical Reasoning in Children (TARC) was employed as a measure of analogical reasoning performance. Results indicated that there was no significant effect for age on analogical reasoning performance, and that age accounted for very little of the variance in TARC performance. Vocabulary knowledge had a significant effect on children's analogical reasoning performance and was the only categorical variable to contribute significantly to total variance. There were no significant gender differences and gender accounted for the least amount of variance on TARC performance. A significant effect for ethnicity on analogy performance was found; however, ethnicity did not contribute significantly to the regression equation. There was also a significant effect for SES on analogy performance and SES did not contribute significantly to the regression equation. (Author/RH)

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EFFECTS OF AGE, VOCABULARY KNOWLEDGE, GENDER, ETHNICITY, AND SOCIOECONOMIC STATUS ON YOUNG CHILDREN'S ANALOGY PERFORMANCE

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Abstract

This investigation examined the influence of age, vocabulary knowledge, gender, ethnicity, and socioeconomic status on the geometric analogy performance of four- to six-year olds. Subjects were 108 children between the ages of 48 and 83 months. Information on the age, ethnicity, and socioecomomic status of each subject was secured prior to data collection. For the determination of vocabulary knowledge, Forms L and M of the Peabody Picture Vocabulary Test were administered. The Test of Analogical Reasoning in Children was employed as a measure of analogical reasoning performance. Results indicated that there was no significant effect for age on analogical reasoning performance and age accounted for very little of the variance in TARC performance. Vocabulary knowledge had a significant effect on children's analogical reasoning performance and was the only categorical variable to contribute significantly to total variance. There were no significant gender differences and gender accounted for the least amount of variance on TARC performance. A significant effect for ethnicity on analogy performance was found, however, ethnicity did not contribute significantly to the regression equation. There was also a significant effect for SES on analogy performance and SES did not contribute significantly to the regression equation.

The Reasoning Capabilities of Four- to Six-Year-Olds: Examining the Influence of Age, Vocabulary Knowledge, Gender, Ethnicity, and Socioeconomic Status on Analogy Performance

Analogical reasoning is an essential cognitive activity, a pervasive component of human intelligence that manifests itself in many forms throughout one's lifetime (Sternberg, 1977). Adults and children employ analogical reasoning processes in the acquisition of knowledge (Rumelhart & Ortony, 1977; Vosniadou & Ortony, 1983), organization and restructuring of knowledge (Holyoak, 1984; Vosniadou & Brewer, 1986). At a more practical level, analogies are instructional tools used by teachers and learners to make novel or complex information comprehensible by relating it to information that is more familiar and simpler (Davidson, 1976). Perhaps because of its theoretical importance and its practical utility, analogical reasoning has received increasing attention in the research literature. Much of this burgeoning interest in analogical reasoning may also be linked to the resurgence of cognitive theory that stresses the interaction between internal and external determinants of performance (e. g., Sternberg & Powell, 1984).

In the case of analogical reasoning, the resurgence of cognitive theory has led researchers to consider the processes that underlie this ability (Sternberg, 1977; 1981) and has allowed for the reexamination of learners' proficiency in relation to those processes and various learner, task and

situational factors (Jenkins, 1979). For instance, the research has shown that analogical reasoning performance may vary as a consequence of: (a) the learner -- whether the learner is younger or older (Sternberg & Nigro, 1980; Wagner, 1983); (b) the task -- whether the problem is presented in a story format (Holyoak, Junn, & Billman, 1984) or as a conventional A:B::C:D analogy problem (Sternberg & Rifkin, 1979); or (c) the situation -- whether or not the task is constructed in a motivational or age-appropriate fashion (Alexander, Willson, White, & Fuqua, 1987; Gelman, 1978; 1979). Recent research has further demonstrated that some young children can spontaneously perform a range of analogy tasks (Alexander, et al., 1988; Brown, Kane, & Echols, 1986; Crisafi & Brown, 1986; Vosniadou & Schommer, 1986), and that young children who do not do so spontaneously can be trained to reason analogically (Alexander, Wilson, et al., 1987; White & Alexander, 1986). Even though the studies we have just cited focused on young children, the majority of analogy research, particularly that dealing with conventional analogy problems, has been conducted with older learners (e.g, Mulholland, Pellegrino, & Glaser, 1980). There have been relatively few studies that have examined young children's performance of analogy problems, and those that have seem most concerned with the question of cognitive competence (Gallagher, 1978; Sternberg & Nigro, 1984). Thus, it would seem that greater research attention should be focused on analogical reasoning in the young and this research should begin to move beyond the

global question of cognitive competence or incompetence. That is to say, in addition to questioning whether young children are or are not capable of reasoning analogically, we should be examining the effect of specific learner, task, and situational variables to analogy performance. In this study, we concentrated on the effect of selected learner variables to young children's performance of an analogy task. Particularly, our intention was to examine the influence of age, vocabulary knowledge, gender, ethnicity, and socioeconomic status on 4- to 6- year-olds' ability to solve geometric analogy problems.

Learner Variables

Age

The first variable of interest to us in this study was chronological age. Given a sample of 4- to 6-year-olds, we wanted to know whether those who appeared more proficient on a geomtric analogy task would be older than those who were less proficient. This question was stimulated by our previous research in which we found evidence of reasoning differences between 4- and 5- year-olds. In one study (Alexander, Willson, et al., 1987), we found that there was significantly greater variability in performance of fours than fives. Additionally, in a developmental study of analogy performance of 4- and 5-year-olds (Alexander, et al., 1988), it was observed that children who demonstrated a significant increase in proficiency during the seven-month study, without the benefit of explicit instruction, were older than those who did not.

Together these results suggested to us that age differences for geometric analogy reasoning should be systematically examined with a large sample of young children. In this study, we extended the age range of our subjects to include 6-year-olds. The age range that could be considered was restricted by the dependent measure chosen to assess analogical reasoning. However, we felt that the inclusion of 6-year-olds would contribute important data to the existing literature.

Vocabulary Knowledge

The second variable of interest was vocabulary knowledge. Vocabulary knowledge refers to a verbal ability that is dependent upon receptive understanding and verbal expression of one's native language. In this investigation, we wanted to explore the relationship beteen children's receptive vocabulary and their ability to solve geometric analogy problems. The selection of vocabulary knowledge as a categorical variable in this investigation was based on its practical importance in academic learning and its theoretical relationship to analogical reasoning.

From a practical standpoint, young children's vocabulary knowledge has been strongly correlated with general language competence (Gleason & Pease, 1985) and highly predictive of school success (Owens, 1984). For instance, understanding words seems necessary for later language manipulation, such as that required in the basic tasks of reading and writing. Further, many school achievement and aptitude measures include some

assessment of vocabulary knowledge (Dunn & Dunn, 1981; Owens, 1984). At a more theoretical level, vocabulary knoweldge has been considered indicative of world knowledge; that is, the words one understands and uses is representative of schematically-held knowledge (Freebody & Anderson, 1979). In addition, the acquisition of vocabulary knowledge may be based on some form of associative learning where a relation is made between the verbal symbol, the word, and the concept that word represents (Moerk, 1977). This associative learning appears to bear some resemblance to the component processes underlying analogical reasoning and warrants empirical examination. Despite these practical and theoreticl rationales, we identified no studies in our search of the literature that had undertaken an investigation of the influence of vocabulary knowledge on the analogical reasoning capabilities of young children.

Gender Differences

For the purpose of this study, we sought to evaluate potential differences in the geometric analogy performance between the young boys and girls in our sample. It is widely acknowledged that there is a differential performance pattern for males and females on cognitive tasks, with females generally scoring higher on verbal tasks and males scoring higher on spatial and mathematical tasks (Hiscock & Mackay, 1985; Hoyenga & Hoyenga, 1979; Maccoby & Jacklin, 1974). However, there is considerable argument about gender effects on cognitive tasks when the subjects are young children (Petersen, 1980).

In this investigation, we wanted to assess gender difference among young boys and girls on a cognitive task that entailed spatial abilities. Spatial ability generally refers to the representation, transformation, generation, and recall of symbolic information, as well as the visualization and mental rotation of three-dimensional objects (Linn & Peterson, 1985). One specific spatial ability of relevance to the education of the young is spatial visualization that incorporates the discrimination of left and right, and the identification and discrimination among geometric shapes.

When considering spatial ability, gender differences have been evidenced in early adolescence and throughout adulthood (Maccoby & Jacklin, 1974; Vandenburg & Kuse, 1979). The few studies that have assessed gender effects on spatial ability of the young, however, have produced mixed effects. For example, in their review of sex related differences in spatial abilities, Vandenburg and Kuse (1979) concluded that boys and girls appeared equally capable on spatial tasks in the preschool and early elementary school years. Similarly, no significant relationship between performance on either the Raven's Coloured Progressive or Standard Progressive Matrices and gender were observed in several research studies (Court, 1983; Garrity & Donaghue, 1976). In contrast, Kamphaus, Kaufman, & Reynolds (1985) discussed gender differences which favor young girls on all global scales and subtests, including matrix analogies, on the Kaufman Assessment Battery for Children. Thus, because of the paucity of studies

involving young children, and the mixed results of that limited research, we felt that an examination of gender difference in this study was desirable.

Ethnicity

In addition to the variables of age, vocabulary knowledge, and gender, we were interested in the effect of ethnicity on geometric analogy performance among Hispanic, Black, and White children. There were two reasons we chose to analyze the influence of ethnicity on analogy performance. First, there are few studies that have undertaken an examination of the relationship between geometric analogy performance and ethnicity among the young, and we wanted to expand the available literature in this area.

Second, whereas the differential performance of minority populations on measures of cognitive ability has been well documented (e.g., Hughes & Noppe, 1985; Loehlin, Lindzy, & Spuhler, 1975), there remains much controversy as to causality. Some researchers argue that performance variability among ethnic groups primarily results from factors that are inherent in those individuals (Scarr, 1981), others feel that external, environmental factors are the principal cause of these reported differences (Mackenzie, 1984), and still others find the nature of the task to be a major contributor to ethnic differences (Neisser, 1986). The present study would permit us to evaluate ethnic differences in cognitive ability under more favorable task conditions. By employing an instrument that is largely

manipulative, nonverbal, and motivating to young children, we had the opportunity to consider the argument that task conditions are major contributors to the reported differences among ethnic groups. Should no difference for ethnicity be found in this study, then this would provide support for the position that task conditions may have exacerbated such differences in the past.

Socioeconomic Status

The final learner variable considered in this study was socioeconomic status or SES. As with ethnicity, much variability in performance on cognitive measures can be accounted for by SES level (Lesser, Fitch, & Clark, 1965). Simply stated, research has shown that the higher the SES level, the better, generally, the performance on cognitive tasks (Scarr, 1981). The influence of SES level has been well documented in the literature on intelligence. For example, in a study which examined variance in IQ scores among 4-year olds, Broman, Nichols, and Kennedy (1975) found that IQ correlated at the highest levels with SES. According to this literature, there is a strong relationship between intelligence and SES that holds across both minority (i.e, Blacks, and Hispanic) and majority (i.e., White) cultures (Scarr, 1981). To some, this descrepance in performance between low and middle/upper SES groups is the consequence of environmental deprivation among lower SES children. That is, these low SES children lack the physical and social environment that is likely to stimulate development of their intellectual potential (Heath, 1982; Hess & Shipman, 1965; 1968).

Additionally, low SES children who are less experienced in the quasi-academic rituals of middle-class homes may well score lower on acdemically-oriented tasks than those children who are more experienced (Boyce, 1983). Evidence of this phenomena can be seen in the research of Burns, Haywood, & Delclos (1985). In their work on dynamic assessment, Burns et al. found that the performance patterns of low SES children may be attributable to their lack of certain test-taking strategies. More specifically, it was observed that the low SES children (a) scanned test materials fewer times than higher SES children; (b) were more impulsive in their approach to the task, and, (c) used a less systematic technique for problem solving than higher SES youngsters. However, Burns et al. felt that many of the strategic disadvantages exhibited by low SES children could be compensated for by less traditional test-taking routines.

The cognitive measures used to assess analogical reasoning capabilties in the present study was a more concrete, largely manipulative task. Because of the less traditional nature of this task and its requirement of more interaction between examiner and child, we felt that the assessment of the influence of socioeconomic status on analogy performance was warranted. Should there be no significant effect for SES on analogy performance in this study, credence would be given to the argument for use of less traditional assessment procedures as espoused by Burns et al. (1985) and others (Brown & French, 1979; Delcos, Burns, & Kulewicz, 1987).

Summary

It was the purpose of this investigation to examine analogical reasoning in young children from the perspective of selected learner variables. The specific variables chosen for study were age, vocabulary knowledge, gender, ethnicity, and socioeconomic status. Based on the available literature and our understanding of the analogy task to be used in this investigation, we would predict the following results:

1. Age would have a significant effect on analogy performance, with the older children scoring higher than the younger.
2. Because of the more concete and noverbal nature of the analogy task used, there would not be a significant effect for vocabulary knowledge on analogy performance.
3. In light of the young age of the subjects there would be no marked differences in geometric analogy performance between the males and females in our sample.
4. Performance for Blacks, Hispanics, and Whites on the analogy measure would be similar due to the nature of the task.
5. No significant effect for SES on analogy performance would be demonstrated in this study because of the less traditional assessment procedure employed.

Method

Subjects

The subjects for this investigation were 108 children

between the ages of 48 and 83 months. The mean age of the children was 64.06 months. These subjects were from seven sites in northcentral (n=9), central (n=14), and northwest Texas (n=23), northeast Georgia (n=46), and northwest Virginia (n=16). In establishing the pool of subjects for this investigation, attempts were made to secure a sample representing different socioeconomic levels and ethnicity backgrounds. The determination of low socioeconomic status was based on federal guidelines for qualification for federally-subsidized programs, such as the free lunch program, as determined primarily by family income.

All children at the northcentral and central Texas, and the northeast Georgia site meeting the specified age requirement (i.e., between 4 and 6 years of age), were included in the sample. A randomly-selected subset of 19 6-year olds was selected from a larger pool of subjects (n=43) at the northwest Texas site and a randomly-selected subset of 17 5- and 6-year olds was selected from a larger pool (n=40) of subjects at the northwest Virginia site. The breakdown of the sample in terms of the variables of interest in this investigation was as follows: 44 4-year olds, 32 5-year olds, and 32 6-year olds; 12 well-above average, 19 above average, 20 average, 35 below and 22 well-below average in vocabulary knowledge; 54 males and 54 females; 70 white children, 21 Hispanics, and 17 Blacks; and 61 low SES, and 47 middle/high SES.

Materials

In the investigation two instruments were utilized. For the determination of vocabulary knowledge, the Peabody Picture Vocabulary Test or PPVT (Dunn & Dunn, 1981), Forms L and M, was given. The PPVT was designed as an individual screening device of what Dunn and Dunn describe as receptive or hearing vocabulary. While not intended to serve as a comprehensive measure of general intelligence, the PPVT is a standardized instrument that is widely applied in school and clinical settings to assess vocabulary acquisition. The test was designed for use with subjects between 2.5 and 40 years of age, "...who can see and hear reasonably well, and understand Standard English to some degree" (Dunn & Dunn, p. x).

Specifically, the PPVT consists of 180 items ordered by difficulty; five of these serve as practice items. As seen in Figure 1, each item is composed of four simple black and white illustrations, presented in a 2 x 2 matrix. The subject demonstrates understanding of a vocabulary term by selecting one illustration, among the four, that best represents the word spoken by the examiner. For instance, for item 43, Form L, displayed in Figure 1, the subject points to the illustration that best represents the word "shoulder".

Insert Figure 1 about here

A testing session is estimated to last from 10 to 20

minutes. A basal level is found for each subject by identifying eight consecutive correct items, and a ceiling is achieved when six of the last eight responses are scored as incorrect. Test scores are reported in five forms: raw score, standard score, percentile rank, stanine, and age equivalent. For the purposes of this study, only standard scores (M=100, SD=15) were used to establish the categories for vocabulary knowledge. Children receiving a standard score of 129 or above were categorized as well-above average in vocabulary knowledge. The remaining categories and their corresponding standard scores were above average (115 to 128), average (100 to 114), below average (85 to 99), and well-below average (84 or below). (See the manual for data on the reliability and validity of the PPVT.)

As a measure of analogical reasoning performance, the Test of Analogical Reasoning in Children or the TARC was used (Alexander, Willson, et al., 1987). The TARC is a test of analogy problem solving presented in a game-playing format. As with the PPVT, the TARC is an individually-administered test of cognitive ability. While the PPVT assesses vocabulary knowledge, the TARC measures a child's nonverbal problem solving. The TARC is composed of 16 geometric analogy problems assembled in an A:B::C:? array with four options from which the final D is to be selected. The four options are displayed vertically to the right of the item stem. The first two items of the TARC serve as practice items and are not included in analysis.

Four versions and five forms of the TARC have been developed

(Alexander, et al., 1988). In the current research, 59 subjects were administered the game version, Form A, and 45 were administered the reduced paper version, Form E. (See Willson, et al., 1986; for a discussion of the reliability and validity of the TARC versions and forms.) A sample item from each of the two forms is presented in Figure 2.

Insert Figure 2 about here

The game and reduced paper versions differ in that the game version is a manipulative task. The stem of the analogy problem is constructed of attribute blocks varying on the dimensions of size (large, small), shape (square, rectangle, circle, triangle), and color (red, blue, yellow). The options are four attribute blocks that are laid out vertically to the right of the gameboard. The child picks up and places the desired block on the gameboard to indicate selection. By constrast, the reduced paper version more closely approximates, in size and format, the type of problems appearing on tests of aptitude or achievement (e.g., Kaufman-Assessment Battery for Children, Raven's Coloured Progressive Matrices). The child marks the selected option with either a grease pencil or a game piece.

In administering the TARC, children are told that they are going to be playing a game, and that in this game they must find the piece that goes with the C term the same way that the terms A and B go together. The rules of the game are repeated with each

new item, and credit is given for the selection of the correct option. The level of proficiency is then calculated as a raw score on the basis of the number correct. Both versions of the TARC take approximately 25 minutes to administer.

Procedures

Information on the age, ethnicity, and socioeconomic status of each subject was secured from written documentation available at each of the testing sites. Such documentation was secured prior to test administration. Parental permission was also obtained for all children participating in this investigation.

In all cases, care was taken to familiarize the child with the environment before testing. Further, in a majority of cases, the site of testing was the child's day-care, preschool, or school facility. All examiners had classroom and clinical experience with young children, and had administered and scored the PPVT and TARC prior to this investigation. However, all protocols for the PPVT and TARC were examined by the authors to ensure accuracy.

The order of testing was systematically varied at each site to control for any possible order effects. That is, whether the PPVT or TARC was to be administered first was randomly determined. Typically, the children met with the examiner on two sessions conducted over two days, with one of the instruments administered at each session. On a very few occasions, due to time constraints a child was given both tests in one day with time allotted between test administrations.

Results and Discussion

It was the intent of this investigation to examine the influence that age, vocabulary knowledge, gender, ethnicity, and socioeconomic status play on the analogical performance of young children. As noted, the dependent measure in analysis was the mean number correct on the Test of Analogical Reasoning in Children. Means and standard deviations for the 108 children tested are displayed in Table 1 by categorical variables of interest. Because no significant difference was found for the game or reduced versions of the TARC, scores for these two versions were collapsed. Effects for the categorical variables on TARC performance were analyzed by means of analysis of variance and regression procedures. Each of these variables will now be discussed in turn.

Insert Table 1 about here

Age

The predicted effect for age on analogical reasoning performance did not emerge for this sample of 4- to 6- year olds, $F<1$, $p>.05$. Somewhat surprisingly, the 5-year olds in this study outperformed the 6-year olds on the TARC, although not significantly so. This finding deviates from previous research with the TARC where differences between 4- and 5-year olds were found (Alexander, Willson, et al., 1987).

As seen in Table 2, a multiple regression was performed.

The final regression equation specifying all categorical variables significantly accounted for 20 percent of the total variance, $F(5,102)=6.26$, $p<.0001$. The beta values shown in Table 2 represent the weights accorded each of the categorical variables in the final regression equation. The F-ratios reflect the significance of the variance that is attributed to each categorical variable independent of the effects of all other variables. In this equation, the categorical variable age resulted in an R of only .01, which indicates that age accounted for very little of the variance in TARC performance. No possible explanation for the lack of effect for age is posited.

Insert Table 2 about here

Vocabulary Knowledge

Vocabulary knowledge was determined to have a significant effect on children's analogical reasoning performance, $F(4,103) = 9.58$, $p<.0001$, $MSe=15.22$. Following the determination of a main effect for vocabulary knowledge, additional pairwise analyses were conducted. Results of the Bonferroni (Dunn) T tests indicated that those children with well-above average vocabulary knowledge were significantly different in analogy performance from students who were average, below average, and well-below average in vocabulary knowledge. In addition, students who were above average in vocabulary knowledge performed significantly differently on the TARC than did students who were well-below

average in vocabulary knowledge.

The strength of the relationship between PPVT and TARC was attested to by the regression analysis. Of all the variables entered into the regression model, PPVT was the best predictor of TARC performance, accounting for approximately 22% of the total variance. PPVT was the only categorical variable to contribute significantly to the total regression equation.

The contrast between the language-based, more crystallized PPVT and the geometric, more novel TARC seems quite evident. However, the strong association between these two tasks might be explained by certain similarities in the two tasks that were not immediately apparent. First, both the PPVT and TARC are tests of cognitive ability; therefore, performance on both may well be reflective of the general intellectual ability or the cognitive development of the children tested.

Second, the demands on working memory for the PPVT and TARC seem comparable. Both involve attention to and manipulation of four stimuli in the problem stem and require the selection of a correct response form four options. Further, in both cases, subjects are required to indicate selection; no verbal responses are required for either test. Finally, the PPVT requires the child to infer a relationship between the spoken word and a pictoral representation of that word. According to componential analysis of analogy tasks (Sternberg, 1977), inferring is a primary component in the successful performance of analogy problems such as those on the TARC.

Gender

As we noted, few studies have systematically examined gender differences in spatial ability in subjects below the age of seven. In the present study, the effect of gender on analogy performance of 4- to 6-year olds was assessed. This analysis was performed because it was felt that the TARC entails the mental or physical mainpulation of geometric stimuli, therefore the TARC involves spatial abilities such as spatial perception, memory, and reasoning.

Although females performed somewhat better than males on the TARC, analysis of data showed no significant gender differences for the sample tested, $F<1$, $p>.05$. The lack of influence contributed by gender was also indicated in the regression analysis where gender accounted for the least amount of variance in TARC performance. These results offer support for the position of researchers such as Maccoby & Jacklin (1974) that gender differences in spatial ability are late emerging.

Ethnicity

In order to assess the main effects and interaction of ethnicity and SES, the effect of these two variables were analyzed in a 3 (ethnicity: White, Hispanic, vs. Black) X 2 (SES: middle/high vs. low) analysis of variance procedure. Since the interaction between ethnicity and SES was nonsignificant, $F<1$, $p>.05$, only the main effects will be discussed.

There was a significant effect for ethnicity on analogy performance, F (2,102)=7.75, p=.007, MSe=15.53 In order to

better assess the source of this difference, Bonferroni (Dunn) T tests were performed. From these pairwise tests, it was determined that Whites significantly outperformed Blacks on the TARC. However, this difference may be reflective of the disparity in number of Whites versus Blacks in this study sample. No differences between Whites and Hispanics or Hispanics and Blacks were demonstrated. These results suggest that the only ethnic group performance differences were evident between Blacks and Whites. In the regression model, ethnicity accounted for only about 4 percent of the variance in analogy performance.

SES

A significant effect for SES on analogy performance was found, F (1,102)=7.83, p=.006, MSe=15.53. Children from middle to high SES homes outperformed children from low SES homes on the TARC. However, in terms of the regression analysis, this categorical variable, which accounted for about 7 percent of the variance in analogy performance, did not contribute significantly to the regression equation. These two findings indicate that in and of itself, SES exerted a significant influence on TARC performance. Yet, when combined with the other categorical variables of interest, SES was not a significant predictor of TARC performance.

While the TARC may be considered a novel, noverbal task there are plausible explanations for the differential performance of middle/high and low SES children. One explanation is that experiences related to TARC performance occur differentially as

a consequence of SES level. That is, low SES children may not be as familiar with the attribute blocks or game-playing routine employed in the TARC as children of middle/high SES homes. Another explanation is that low SES children may be less motivated by or proficient at tasks that are not directly relevant to their day-to-day experiences. For example, the effects for SES may have been different had these children been asked to solve analogy problems that invovlved more motivating concrete objects such as toy cars, or animals, rather than attribute blocks.

General Discussion

Although these findings help to clarify the potential effect of the learner variables on analogical reasoning performance in young children, additional questions and issues remain. The nonsignificant age differences in performance between 4-, 5-, and 6-year-olds contradicts traditional, cognitive developmental theory as well as previous research with the TARC. These results may be due to the size and diversity of this sample population, however, additional examination of age-related performance on analogical reasoning tasks among young children needs to be conducted.

The strong relationship between verbal ability and geometric analogy performance should be further delineated and specified. Performance on other measures of verbal ability such as intelligence and achievement tests needs to be compared to analogical reasoning ability. Additional investigations should

address questions related to how vocabulary knowledge and analogical reasoning can be instructionally linked in early childhood programs. For example, how can analogical reasoning processes be incorporated into language activities which seek to establish associations between words and concepts or words and symbols?

The lack of influence of gender on analogical reasoning performance provides evidence that young boys and girls are equally capable at performing this spatial visualization task. Even though these results are in agreement with prior research, there have been fewer studies which examine gender differences on spatial visualization tasks among young children. Additional investigations which examine gender as a variable in the performance of spatial visualization tasks with the young should be conducted.

In terms of ethnicity and SES, the current findings indicate that both SES and ethnicity has an effect on geometric analogy performance. These findings must be considered in light of previous research which demonstrated the difficulty in isolating either of these variables when they are considered together. Evidence for concluding which of these two variables clearly influences the ability to solve geometric analogy problems is not complete. Additional investigations which seek out the presence of higher level thinking skills such as analogical reasoning in children from different ethnic, SES, and cultural, groups need to continue. We must also examine the types of assessment contexts

which best facilitate performance.

Examination of the instructional potential for higher level thinking skills such as analogical reasoning with different ethnic, SES, and cultural groups must also be considered. This potential may help us find ways to deliver instruction which makes learning more lasting and meaningful to these young learners. In addition, further investigation related to both performance capabilities and instructional potential may help to answer larger questions related to what should be included in early childhood curriculum and how the curriculum should be delivered.

References

Alexander, P. A., Willson, V. L., White, C. S., & Fuqua, J. D. (1987). Analogical reasoning in young children. Journal of Educational Psychology, 79, 401-408.

Alexander, P. A., Willson, V. L., White, C. S., Fuqua, J. D., Clark, G. D., Wilson, A. F., & Kulikowich, J.M. (1988). Analogical reasoning development of four- and five-year olds. Manuscript submitted for publication.

Alexander, P. A., Wilson, A. F., White, C. S., Willson, V. L., Tallent, M. K., & Shutes, R. E. (1987). Effects of teacher training on children's analogical reasoning performance. Teaching & Teacher Education, 3, 275-285.

Boyce, C. M. (1983). Black proficiency in abstract reasoning: A test of Jensen's two-level theory. Unpublished doctoral dissertation: Cornell University.

Brown, A. L., & Delouche, J. S. (1978). Skills, plans, and self-regulation. In R. S. Siegler (Ed.), Children's thinking: What develops? (pp. 3-35). Hillsdale, NJ: Erlbaum.

Brown, A. L., Kane, M. J., & Echols, C. H. (1986). Young children's mental models determine analogical transfer across problems with a common goal structure. Cognitive Development, 1, 103-121.

Burns, S., Haywood, H. C., Delclos, V. R., & Siewert, L. (1985). Young children's problem solving strategies: An observational study. (Tech. Rep. No. 1). Nashville, TN: Vanderbilt University.

Court, J. H. (1983). Sex differences in performance on Raven's progressive matrices: A review. The Alberta Journal of Educational Research, 29, 54-74.

Crisafi, M. A., & Brown, A. L. (1986). Analogical transfer in very young children: Combining two seperately learned solutions to reach a goal. Child Development, 57, 953-968.

Davidson, R. E. (1976). The role of metaphor and analogy in learning. In J. R. Levin & V. L. Allen (Eds.), Cognitive learning in children: Theories and strategies (pp. 135-162). New York: Academic.

Dunn, L. M., & Dunn, L. M. ((1981). Peabody picture vocabulary test-revised manual for forms L and M. Circle Pines, MN: American Guidance Service.

Freebody, P. & Anderson R. C. (1983). Effects of vocabulary difficulty, text cohesion, and schema availability on reading comprehension. Reading Research Quarterly, 18, 277-294.

Garrity, L. I., & Donaghue, J. T. (1976). Preschool children's performance on the Raven's coloured progressive matrices and the Peabody picture vocabulary test. Educational and Psychological Measurement, 36, 1043-1047.

Gallagher, J. M. (1978). Reflexive abstraction and education: The meaning of activity in Piaget's theory. In J. M. Gallagher, & J. A. Easley (Eds.), Knowledge and development: Vol. 2. Piaget and education (pp. 1-20). New York: Plenum.

Gelman, R. (1978). Cognitive development. Annual Review of Psychology, 29, 297-332.

Gelman, R. (1979). Preschool thought. American Psychologist, 34, 900-905.

Gick, M. L., & Holyoak, K. J. (1980). Analogical problem solving. Cognitive Psychology, 12, 306-355.

Gleason, J. B., & Pease, D. (1985). Gaining meaning: Semantic development. In J. B. Gleason (ed.), The Development of Language (pp. 103-138). Columbus: Merrill.

Heath, S. B. (1982). What no bedtime story means: Narrative skills at home and school. Language in Society, 11, 49-76.

Hess, R. D., & Shipman, V. C. (1968). Maternal influences upon early learning: The cognitive environments of urban pre-school children. In R. D. Hess & R. M. Bear (Eds.), Early Education (pp. 91-103). Chicago: Aldine.

Hiscock, M. & Mackay, M. (1985). Neuropsychological aproaches to the study of individual differeneces. In C. R. Reynolds & V.L. Willson (Eds.), Methodological and statistical advances in the study of individual differences (pp. 117-176). New York: Plenum.

Holyoak, K. J. (1984). Analogical thinking and human intelligence. In R. J. Sternberg (Ed.), Advances in the psychology of human intelligence: Vol. 2 (pp. 199-230). Hillsdale, NJ: Erlbaum.

Holyoak, K. J., Junn, E. N., & Billman, D. O. (1984, April). Development of analogical problem-solving skill. Paper presented at the annual meeting of the American Educational Research Association, New Orleans.

Hoyenga, K. B., & Hoyenga, K. T. (1979). The question of sex differences. Boston: Little, Brown and Company.

Hughes, F. P., & Noppe, L. D. (1985). Human development across the life span. New York: West.

Jenkins, J. J. (1974). Four points to remember: A tetrahedral model of memory experiments. In L. S. Cermak & F. I. M. Craik (eds.), Levels of processing in human memory, pp. 429-446, Hillsdale, NJ: Erlbaum.

Kamphaus, R. W., Kaufman, A. S., & Reynolds, C. R. (1985). Application of the Kaufman Asessment Battery for Children to the study of individual differences. In C. R. Reynolds & V. L. Willson (Eds.), Methodological and statistical advances in the study of indivdual differences (pp. 177-207). New York: Plenum.

Lesser, G. S., Fifer, G., & Clark, D. H. (1965). Mental abilities of children from different social-class and cultural groups. Monographs of the Society for Research in Child Development, 30, No. 4.

Linn, M. C., & Petersen, A. C. (1985). Emergence and characterization of sex differences in spatial ability: A meta-analysis. Child Development, 56, 1479-1498.

Loehlin, J. C., Lindzey, G., & Spuhler, J. N. (1975). Race differences in intelligence. San Francisco: W. H. Freeman.

Maccoby, E. E., & Jacklin, C. N. (1974). The psychology of sex differences. Stanford, CA: Stanford University Press.

MacKenzie, B. (1984). Explaining race differences in IQ: The logic, the methodology, and the evidence. American Psychologist, 39, 1214-1233.

Mourk, E. L. (1977). Pragmatic and semantic aspects of early language development. Baltimore: University Park Press.

Mulholland, T. M., Pellegrino, J. W., & Glaser, R. (1980). Components of geometric analogy solution. Cognitive Psychology, 12, 252-284.

Neisser, U. (1986). New answers to an old question. In U. Neisser, (ed.) The School Achievement of Minority Children (pp. 1-17). Hillsdale, NJ: Erlbaum.

Owens, R. E. Jr. (1984). Language development: An introduction. Columbus: Merrill.

Petersen, A. C. (1980). Biopsychosocial processes in the development of sex-related differences. In J. Parsons (Ed.), The psychology of sex differences and sex roles (pp. 31-35). New York: Hemisphere.

Rumelhart, D. E., & Ortony, A. (1977). The representation of knowledge in memory. In R. C. Anderson, R. J. Spiro, & W. E. Montague (Eds.), Schooling and the acquisition of knowledge (pp. 99-135). Hillsdale, NJ: Erlbaum.

Scarr, S. (1981). Race, social class and individual differences in IQ. Hillsdale, NJ: Erlbaum.

Sternberg, R. J. (1977). Intelligence, information processing, and analogical reasoning: The componential analysis of human abilities. Hillsdale, NJ: Erlbaum.

Sternberg, R. J. (1982). Nonentrenchment in the assessment of intellectual Giftedness. Gifted Child Quarterly, 26, 63-67.

Sternberg, R. J., & Nigro, G. (1980). Developmental patterns in the solution of verbal analogies. Child Development, 51, 27-38.

Sternberg, R. J., & Powell, J. S. (1984). The development of intelligence. In P. H. Mussen (Ed.), Handbook of Child Psychology. New York: Wiley.

Sternberg, R. J., & Rifkin, B. (1979). The development of analogical reasoning processes. Journal of Experimental Child Psychology, 27, 195-232.

Vandenberg, S. G., & Kuse, A. R. (1979). Spatial ability: A critical review of the sex-linked major gene hypothesis. In M. A. Wittig & A. C. Petersen (Eds.), Sex Related Differences in Cognitive Functioning (pp. 67-95). New York: Academic.

Vosniadou, S., & Brewer, W. F. (1987). Theories of knowledge restructuring in development. Review of Educational Research, 57, 51-67.

Vosniadou, S., & Ortony, A. (1983). The influence of analogy in children's adquisition of new information from text: An exploratory study. (Tech. Rep. No. 281). Champaign, IL: University of Illinois, Center for the study of reading.

Vosniadou, S., & Schommer, M. (1986, April). The effect of explanatory analogies on young children's comprehension of expository text. Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Wagner, J. (1983, April). Some prerequisites in learning to solve analogy problems. Paper presented at the American Educational Research Association, Montreal, Canada.

White, C. S., & Alexander, P. A. (1986). Examining the effects of direct instruction on four-year olds' ability to solve geometric analogy problems. Cognition and Instruction, 3, 261-268.

Willson, V. L., Alexander, P. A., White, C. S., Fuqua, J. D., Clark, G. D., & Wilson, A. F. (1986). Form and presentation variation in a test of geometric analogies. Paper presented at the American Educational Research Association, San Francisco.

Means and Standard Deviations for TARC Performance by the Categories of Age, Vocabulary Knowledge, Gender, SES, and Ethnicity

	TARC Performance		
Category	n	M	SD
Age			
Four	44	5.55	4.05
Five	32	6.78	4.29
Six	32	6.34	4.79
Vocabulary Knowledge			
Well-Above (129 and above)	12	10.25	3.67
Above Average (115 to 128)	19	8.32	4.53
Average (100 to 114)	20	6.15	4.72
Below Average (85 to 99)	35	5.29	3.62
Well-Below Average (84 and below)	22	3.41	2.65
Gender			
Male	54	5.80	4.15
Female	54	6.50	4.54
SES			
Middle/High	47	7.47	4.61
Low	61	5.31	3.86
Ethnicity			
White	70	6.93	4.53
Hispanic	21	5.38	2.83
Black	17	3.88	4.07

a out of a possible 14

Table 2

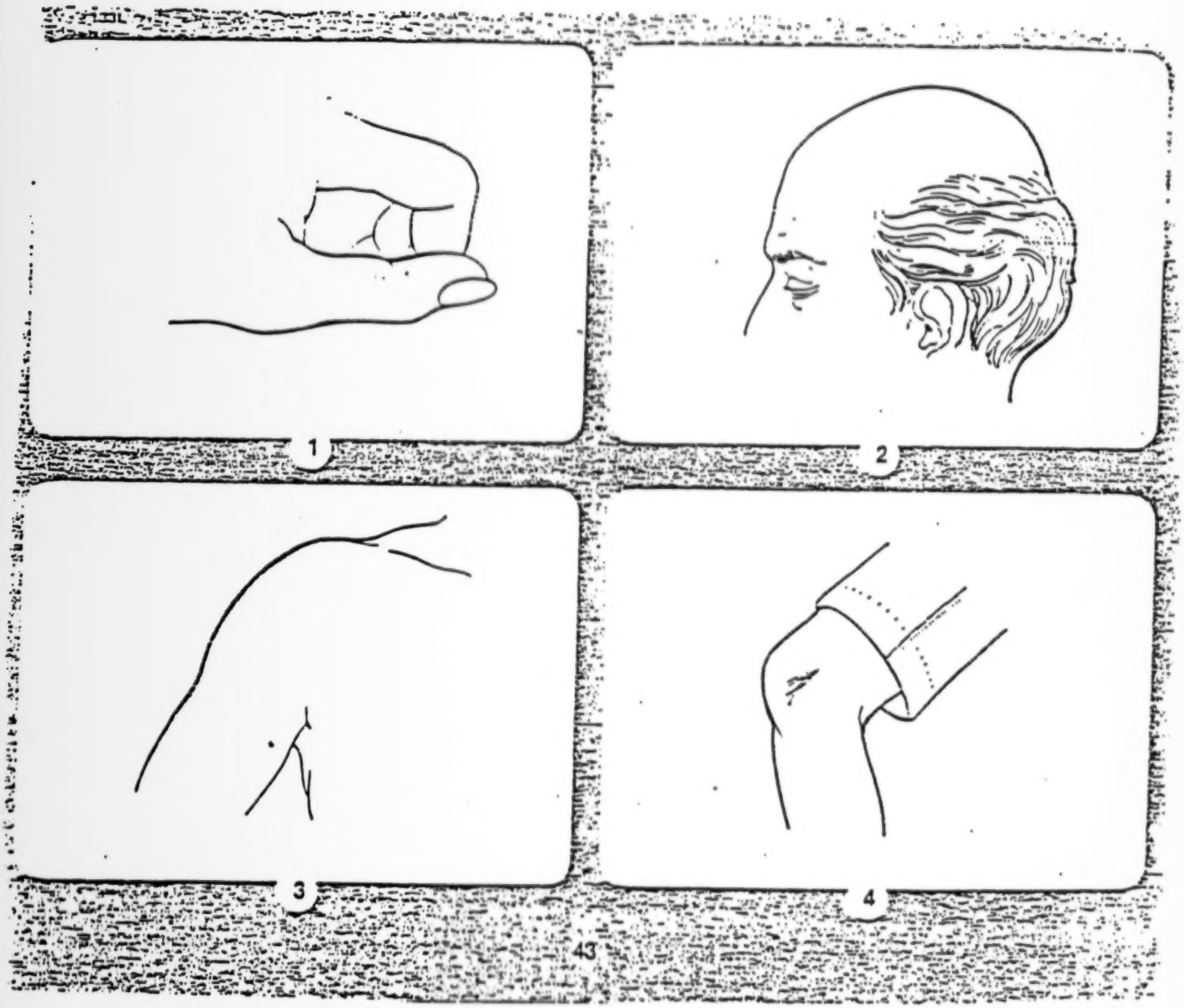
Summary of Simultaneous Regression Analysis for TARC Performance

Category	R	Beta	F-ratios	p
Age	.01	.03	.64	.43
Vocabulary Knowledge	.22	.08	16.97	.00
Gender	.01	.61	.63	.44
SES	.07	.05	.00	.96
Ethnicity	.04	-.43	.68	.41

Figure Captions

Figure 1. Sample item #43, Form L, Peabody Picture Vocabulary Test.

Figure 2. Sample items; item #4, Form A, and item #4, Form E, Test of Analogical Reasoning in Children.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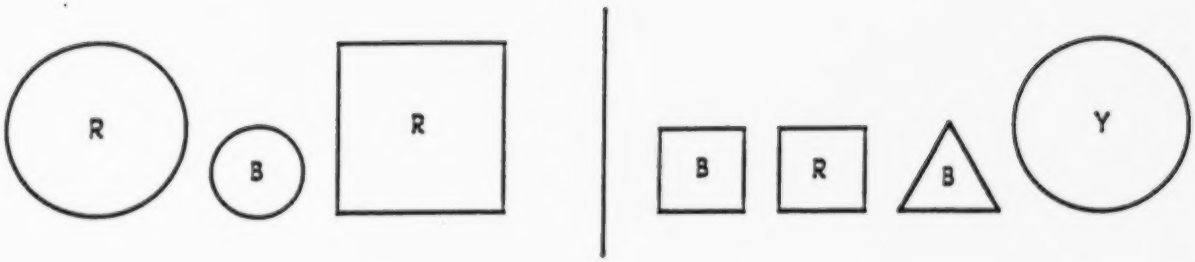
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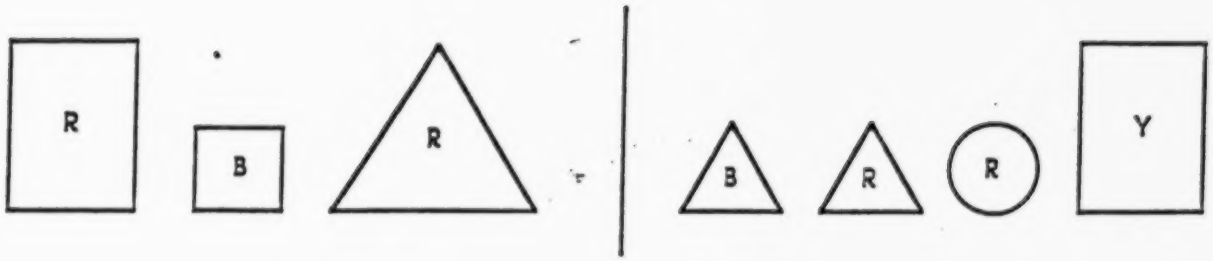
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